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ABSTRACT

Studies comparing computer-assisted instruction with traditional print were reviewed in order to determine what researchers have discovered about using computers in reading. The research findings were then compared and integrated through using the following five categories: interaction, attitude, instructional control, time on task, and efficiency. Most studies indicate that the subjects are more interactive with, and positive toward, computers. Computers help monitor successful learning. Computer groups spend more time on task; however, this is due to the special features used in computers. No definite answer supported either mode of presentation in efficiency. However, the review suggests that the quality of software and hardware may influence computer efficiency and more studies are needed in different instructional situations and subject areas. (Contains 32 references.) (Author/RS)

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Comparing the Use of Computers with Traditional Print in Reading Instruction: What the Research Says

Abstract

This paper reviews the studies on the use of computers vs. traditional print in reading. The review explores the literature through five categories: interaction, attitude, instructional control, time on task, and efficiency. Most studies indicate that the subjects are more interactive with, and positive toward, computers. Computers help monitor successful learning. Computer groups spend more time on task; however, it is due to the special features used in computers. No definite answer supports either modes of presentation in efficiency. The review suggests, however, that the quality of software and hardware may influence computer efficiency and more studies are needed in different instructional situations and subject areas.

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Comparing the Use of Computers with Traditional Print in Reading Instruction: What the Research Says

As computer technology becomes more accessible and cost-effective, there is increasing interest on the part of educators to maximize the potential of its use in classrooms (Fish & Feldmann, 1987). Chaparro and Halcomb (1989) point out that the use of computers in education is becoming nearly as common as the chalkboard; therefore, how to use the computers properly to optimize the academic learning time (Whitaker, Schwartz, & Vockell, 1989), and to improve students' learning are important topics for educators.

Although the microcomputer is an educational tool of unprecedented power, Leigh et al. (1984, p. 4) suggest:

> The potential is great for making serious mistakes when microcomputers are being considered as an aid in the teaching of content or skills. One serious mistake is to adopt computer assisted instructional materials without evidence of effectiveness and efficiency. Computer assisted learning methods need to be compared with and evaluated against more traditional methods of teaching.

However, few studies have directly compared computer-assisted instruction with traditional instruction, and results have been mixed (Kinzer, Sherwood, & Loofbourrow, 1989). This article, therefore, reviews studies which compared computer-assisted instruction with traditional print to deter-

mine what researchers have discovered about using computers in reading.

A comprehensive search of the literature used the following sources: the ERIC system, Current Index to Journals in Education, Resources in Education, and the bibliographies of other related works. Studies that included the act of page-turning and on-line conditions are included in the review. However, the studies conducted before or during the early 1980s are not selected due to the low availability of microcomputers in the nation's classrooms (Ordorensky, 1989) and the hardware limitations that inhibited the development of sophisticated educational software at the beginning of the 1980s (Nuccio, 1989-90). The research findings are then compared and integrated through using the following five categories between the two modes of presentation: interaction, attitude, instructional control, time on task, and efficiency.

Interaction

Researchers have found that readers, when attending to computer- displayed texts, are more active in self-monitoring their comprehension. Keene and Davey (1987) found that the computer group outperformed the printed page group in lookback strategies and in attitude. They concluded that the use of computers may result in greater frequency of text reinspection. Harper and Ewing (1986) added that users' on-line attention to task behavior was also relatively high (80 percent or above). Gifted children and SLD students also

show great concentration when using computer (Boyer, 1984). Sawyer (1988) found that college students used the computerized study guides more often than the conventional study guides in study.

Although most investigators agreed that the students might develop concentration when using computers, some studies also investigated the reasons why students are more involved in using computers. Keene and Davey (1987) explained that lookback strategies may also have been used more frequently as a result of the "fun" associated with manipulation of the machine. Students' desire to improve their reading skills, parents' support and encouragement, and knowledge of the fact that their teacher would be provided with results of their performance may increase their concentration on task (Harper & Ewing, 1986).

Attitude

Most researchers found that their subjects had a preference for or positive attitude toward the use of computers (Gambrell et al., 1987; Harper & Ewing, 1986; Keene & Davey, 1987; Mikulecky, Clark, & Adams, 1989; Morrison et al., 1988; Wepner & Feeley, 1987; Zuk & Danner, 1986). The positive attitude may be used to increase motivation and renders it a particular alluring medium for facilitating the reading performance of LD students (Keene & Davey, 1987) and of students of different school levels.

Although, most researches have found a positive attitude of their subjects toward the use of computers, the users' characteristics have to be taken into consideration. Morrison et al. (1988) found that the CBI group showed less confidence and more conservative attitudes, which, they concluded, might work as a disadvantage for achievement and learning efficiency. They further pointed out that the newness of CBI may cause many subjects to perceive it as more difficult or challenging than print. Harper and Ewing (1986) also found that at the beginning of their study, the subjects expressed a great deal of fear of the microcomputer. It also happened that when the users became familiar with the computer, some would become impatient as they waited for new problem or the cartoon-like characters and reinforcement messages to appear on the screen (Campbell et al., 1985). Boyer (1984) observed that the lower IQ subjects became restless if answers were missed. Weaker readers felt more uncomfortable shifting between passages and questions (Feldmann & Fish, 1987) . Bourgue and Carlson (1987), in their study on "Hands-on vs. computer simulation method in chemistry", found students anxious to interact with the computer and also anxious to return to the classroom to interact on a personal level with the instructor. They concluded that the students accepted the quaint positive learning reinforcement dialogue from the computer as pleasantries, and that students accepted personal learning reinforcement from the instructor with appreciation and a sign of accomplishment. Some users may

lose their interest in using the computer when considering achievement (Balajthy, 1988).

Instructional Control

Findings on instructional control, whether student or computer- based, show a mixed result. MacGregor (1988 a) found that computerized- text system had differential effects on students' vocabulary knowledge, comprehension recall, and on the amount of time students spent on task. However, he concluded that instructional control, whether student or computer based, had no effect on comprehension or time on task. Feeley and Wepner (1986) also pointed out that it did not seem to matter whether students read the selections on screens or in traditional text form, the practice in reading whole-text passages under self-controlled, timed conditions, appeared to increase college students' reading efficiency. Morrison et al. (1988), in their study on learner control using text density as the decision variable, found that the learner control groups learned better than groups receiving standard materials. However, Reinking and Rickman (1990), comparing the vocabulary and comprehension attainment of sixth graders who were put on 4 conditions: off-line dictionary and glossary conditions, on-line self-selection condition, and on-line computer-controlled condition, found that reading comprehension could be increased when computer-mediated texts were used to expand or control options for ac-

quiring information, which also supported the finding (Reinking & Schreiner, 1985) that 11-12 year-old pupils in the all-option group reading high difficulty texts, whether strong or weak readers, performed significantly better than the off-line group. They concluded that increases in comprehension found in other studies employing computer-mediated texts may be due in part to the requirement that subject viewed the meanings of difficult word, and the learning of difficult words during independent reading of informational texts may be enhanced with the aid of a computer.

Some researches investigated the difficulties the learners involved in using learner's control. Balajthy (1988) noted that college level developmental reading students were unable to accurately monitor the success or failure of their own vocabulary learning. He concluded that the computer-based instruction per se was not the cause of poor metacognitive performance. On the contrary, the difficulties may be caused by learner-control, whether in computer-based or traditional formats.

This learners' poor metacognitive use is supported by some studies. Morrison et al. (1988) found that less skilled readers typically selected high-density text while the skilled readers selected low-density text. They pointed out that retrieval of main ideas is not facilitated by providing additional details in the text. Main ideas support the recall of details. Low density text also has the advantage of providing only the essential information needed to learn task

relevant skills. Balajthy (1988) suggested that the teacher must be aware that students have difficulty in monitoring their own learning, both in traditional and in computer-assisted tasks. Due to the learner's poor use of metacognition, he therefore pointed out, learner-control of instruction may result in adverse consequences as a result. Requiring subjects to make decisions concerning which word to investigate may also interfere with other comprehension processes (Reinking & Rickman, 1990).

Further research is necessary regarding whether the purpose of a learner to investigate specifically a word is to increase knowledge or to remove a barrier to comprehension (Reinking & Rickman, 1990) or is due to interest (Balajthy, 1988).

Time on Task

Research findings on time on task between the two modes of text presentation show a mixed result. Clausing and Schmitt (1990) found no significant differences in reading speed from electronic screens to paper. Keene and Davey (1987) found that LD students using computer-presented text spent a similar amount of time reading the passages compared to students reading the traditional printed page. Reinking (1988) noted that reading time for short expository texts appeared to be unaffected by simply displaying the text on a computer screen, but readers used more time to reading computer-mediated

text than to reading texts displayed on printed pages. Haas and Hayes (1985a) found that college students needed more time to retrieve specific information from texts displayed on the computer screen than did students who read the same texts on printed pages. Other studies (Morrison et al., 1988; Zuk & Donner, 1986) concluded that CBI subjects took longer time to finish the task on computer than the print subjects. Morrison et al. (1988) also found that CBI subjects rated the lesson as slower moving than did print subjects, especially when high density material was used.

Researchers have also been trying to explain the reasons why CBI groups take longer in task completion time. Zuk and Danner (1986) explained that the general unfamiliarity or novelty of the computer and the task, and the process of pressing an arrow took longer. This was in sharp contrast with the automatic and familiar printed-page turning process which does not usually require much attention. Leigh et al. (1984), in their study on math drill and practice on computer vs. traditional drill and practice on print pages, pointed out that the print group could readily move from problem to problem, while the computer group had to wait until the graphic reinforcement message was generated and displayed. This process had to be repeated again when new problem was generated. This is supported by Baek and Layne's finding (1988) that the animation group spent significantly more time, because "the subjects were delayed since they were required to wait for the animation se-

quences to run the course before they could continue through the lesson" (p. 135). Reinking (1988) also described that reading and study time might increase when options for assistance were included in computer-mediated text. Reading level may also be a factor affecting reading rate from electronic screens or paper, and readers may reduce their reading rate in order to maintain comprehension (Clausing & Schmitt, 1990).

To solve the reading speed problem, Morrison et al. (1988) proposed that the management system would monitor performance and time on task, and use the data to make appropriate changes in text density level throughout the lesson. If a reader were taking longer than the established mean time, the management program might switch to low-density to improve the user's efficiency.

Further investigations on the effects of computer text presentation on task completion time when longer texts are used and if the reading rate and/or comprehension would deteriorate given longer reading spans (Clausing & Schmitt, 1990; Keene & Davey, 1987) need to be investigated.

Efficiency

Does the use of computers increase students' comprehension and reading efficiency more than the traditional print? The research findings can not provide a definite answer to this question. Taylor and Rosencrans (1986) report-

ed that the use of computer-assisted instruction did not improve vocabulary skills among entry level college students enrolled in a developmental reading program. Zuk and Danner (1986) concluded that subjects were not on task any more often, they did not stay on task any longer, and they did not comprehend better when reading from the computer screen. Sawyer (1988) discovered that college students using traditional study guides performed better than those using computerized study guides. Haas and Hayes (1986) found that adults experienced problems in locating information in word processed text. Their study showed that locating, retrieving, and comprehending textual information displayed on-screen was more difficult than reading from print-out. Cato, English, and Trushell (1989) also found that middle school students generally performed less well locating information on-screen: in particular, students were less successful at locating information within prose passages on-screen. Reinking and Schreiner (1985) found that 11-12 year-old primary pupils performed better on low difficulty tests when reading from print rather than on-screen except the all-option group who produced similar or marginally better performances.

Some studies found no significant differences between computer group and traditional print group at different school levels. Gambrell et al. (1987), in their study conducted on 8 and 10 year-old pupils, reported that there was no significant difference in the performance of 'free recall' and 'cued recall'

tasks when subjects read texts on-screen as opposed to text in-print. Wagner and Feeley (1987) found no significant differences in 'reading comprehension' and 'recall' when third-and fifth-graders read computer vs. printed text. Clausing and Schmitt (1990) did not find a significant difference in eighth grade students reading from electronic screen or paper. Casteel (1988- 89) also found no significant difference between traditional (LD) group using chunked passages and the CAI (LD) training group using chunked passages. Boyer (1984) found that the 5th grade CAI students increased 9 months over the control group; whereas, the control group in the 4th grade increased 4 months over the CAI group.

Some findings do support the use of computers in reading. Goldman (1988), comparing basal reading with computer reading, found that students using computers developed a greater inference ability in reading than did the basal group. She further pointed out that the experimental group ended the study reading at a higher level. Gambrell et al. (1987), when considering age variable, found that older pupils tended to perform slightly better on 'free recall' and 'cued recall' tasks on-screen rather than in-print. Feldman and Fish (1987) concluded that the microcomputer did not seem to hinder the performance of poor readers any more than print. They pointed out that reading from the microcomputer screen was not more difficult than reading from print.

Some researchers also investigated the reasons why the computer group failed to perform better or as well as the print group. Sawyer (1988) pointed out that computerized study guides have some disadvantages when compared with traditional study guides. The use of computers generally limits the time and place in which the study guide can be used (Grabe, Petros, & Sawler, 1989; Sawyer, 1988). Sawyer concluded that the computerized study guide made poor use of study time. He finally suggested, "unless computerized study guides include features not available in conventional study guides, such as interactive, graphics, or simulation, conventional study guides are preferred" (p. 82). Bourgue and Carlson (1987) also suggested that unless a student's comprehension in CAI is monitored closely, the student's assimilation level wanes and his learning does not progress effectively. This can be supported by Reinking and Rickman's finding (1990) that extending or controlling options for assistance in independent reading may increase reader's comprehension.

Conclusion

Research findings have unanimously concluded that subjects in CAI group are more interactive with the task. Subjects are also more positive about the use of computers. This evidence indicates that computers have a potential to develop and improve students' reading or learning if they are used

or integrated properly into classroom setting. However, integrating computers into curriculum requires the knowledge of other factors that might affect students' motivation and attitude toward learning using computers. Novelty may cause either fear, conservation, or excitement. The teacher needs to know how to help students overcome negative feelings. On the other hand, the teacher has to maintain students' motivation and excitement even after the novelty wears away. Otherwise, it is possible that the students may grow tired of using computers once they find nothing particular new or interesting to them.

Although research findings on instructional control show mixed results, we still have to acknowledge that for less able readers, computer control may improve their learning task. Due to poor metacognition, less able readers may not know how to monitor their learning task; they may not understand when there is a need to opt for assistance, or they may know when to find help but they do not know how to find help. Computers can provide this special feature that is impossible when using traditional print.

Most investigators conclude that subjects in CAI group tend to use longer task completion time. However, most of them also point out that there are more features included in computers. These features may help attract attention from the users. They can provide immediate feedback or enough "wait time" for the users to process or understand the underlying reasons why they have missed the question. In this regard, computers act more like a

teacher who is standing or sitting next to the children and is ready to intervene the learning failure, which will naturally take longer time.

Another reason for the increased time on task can be explained through the software itself. It is very common to see different software use different directions to direct the users to run the program. Some require the users to memorize keys; some use arrows; and some use letters. The inconsistency of directions may require a certain amount of time to adjust to the software when they run on computers. This can not compare with the automatic or unconscious page-turning action.

Although research findings on reading comprehension or learning efficiency are not very conclusive, some researchers suggest that the failure to achieve positive results among the experimental computer groups may be due to the inappropriate use or the quality of the software. In evaluating software, we may find that some interesting software fails to produce clear, legible print on screen. Some screens even produce glare. This is evidenced by Feldmann and Fish's finding (1987) that one quarter of the students said reading from the screen hurt their eyes. Some programs are much more complicated to operate. Even some games or problem-solving programs that appear to be interesting and motivational fail to engage students in actual reading due to the fact that the users can bypass the reading to get to a quick solution.

Here, we are not saying that computers can be used to replace current

instructional instruments. However, they can be an additional tool that can be used to help children learn (Kinzer, Sherwood, & Loofbourrow, 1989). The proper use of good computer software can add new and exciting dimension in planning instructional strategies. However, the traditional classroom is still the main focus for the exchanges of ideas and discussion (Bourgue & Carlson, 1987). For understanding more about the benefits of using computers, Kinzer, Sherwood, and Loofbourrow (1989, p. 48) suggest that:

> ...more efforts are needed to determine the effects of types of software, types of computer use, and types of teacher mediation and support across various instructional situations and subject areas. Only when a significant body of such research exists will it be possible to say with some certainty the areas in which instructional computing technologies are most beneficial.

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